

TEMPERATURE CALIBRATION ALONG THE NW IBERIAN MARGIN: MULTI-PROXY APPROACH

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OBJECTIVES

The NW Iberian upwelling system has been largely studied both in terms of physical, biogeochemical and geological processes (e.g. Castro et al., 2000; Olli et al, 2001). However there are no studies focused on improving paleoclimatic proxy calibrations in order to link actual hydrographic and biogeochemical conditions with the past oceanic or climate conditions. This fact has special relevance since it will improve the prediction of future changes against possible climate alteration and anthropogenic influence.

In this framework, we will try to resolve some questions: (1) how the seasonal hydrographic variations affect plankton groups and (2) how much of the water column signal is preserved in the sediments and available for paleo-reconstructions. In order to minimize this lack of information, we will compare present-day water column data (temperature, salinity, dissolved O₂, and oxygen stable isotopes of the water column) registered at two stations (RAIA station: 75 m water depth and CALIBERIA station: 350 m water depth) from July 2010 to October 2011 with trace elements and stable isotopes from planktonic foraminifera, and alkenone SST from a large set of core-top sediment samples from the NW Iberian margin (Fig.1).

PRESENT-DAY HYDROGRAPHIC CONDITIONS

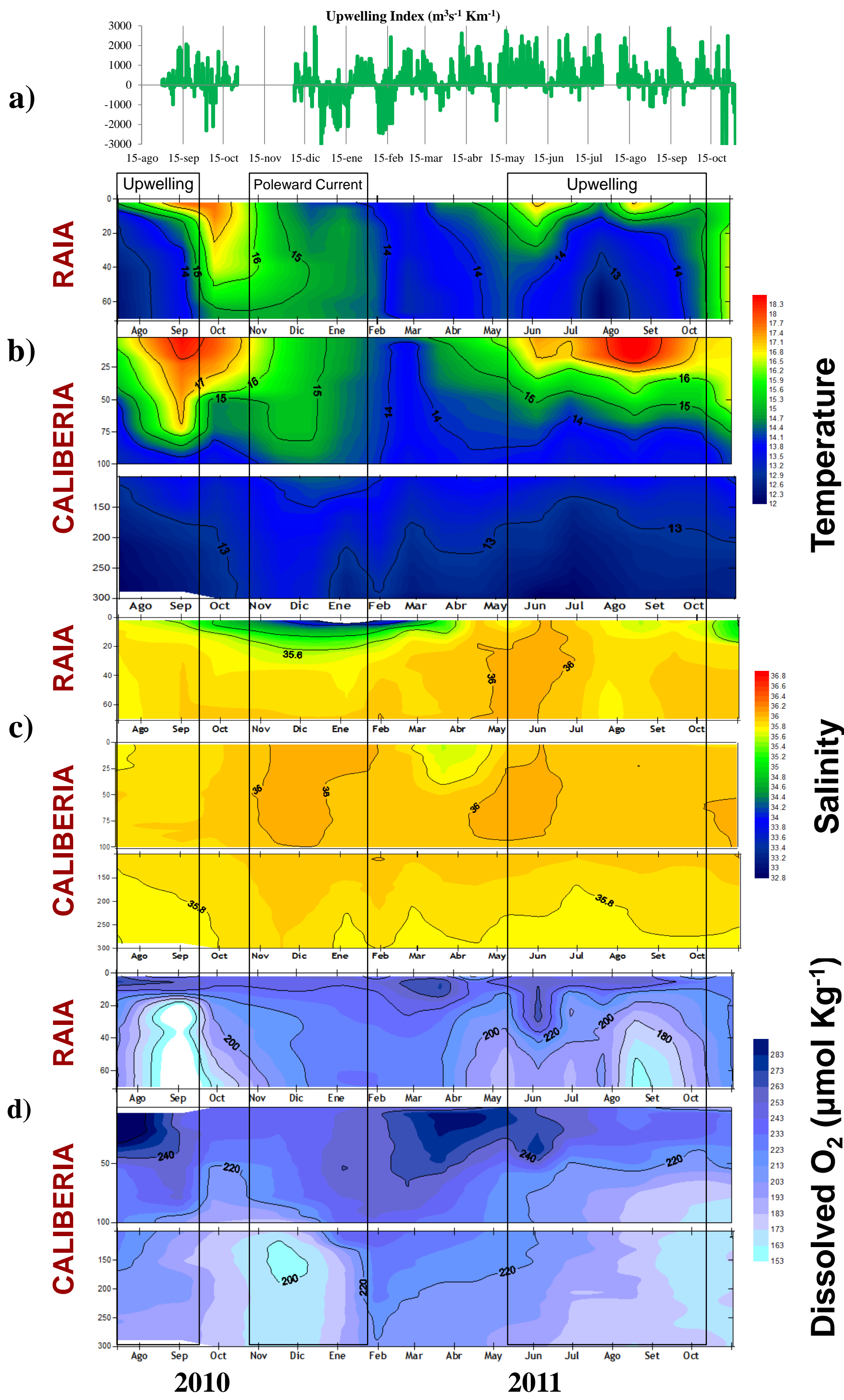


Fig.2. Time-series of (a) upwelling index (m³ s⁻¹ km⁻¹), (b) temperature (°C), c) salinity, and d) dissolved oxygen measured *in situ* at the RAIA and CALIBERIA stations; between July 2010 and November 2011.

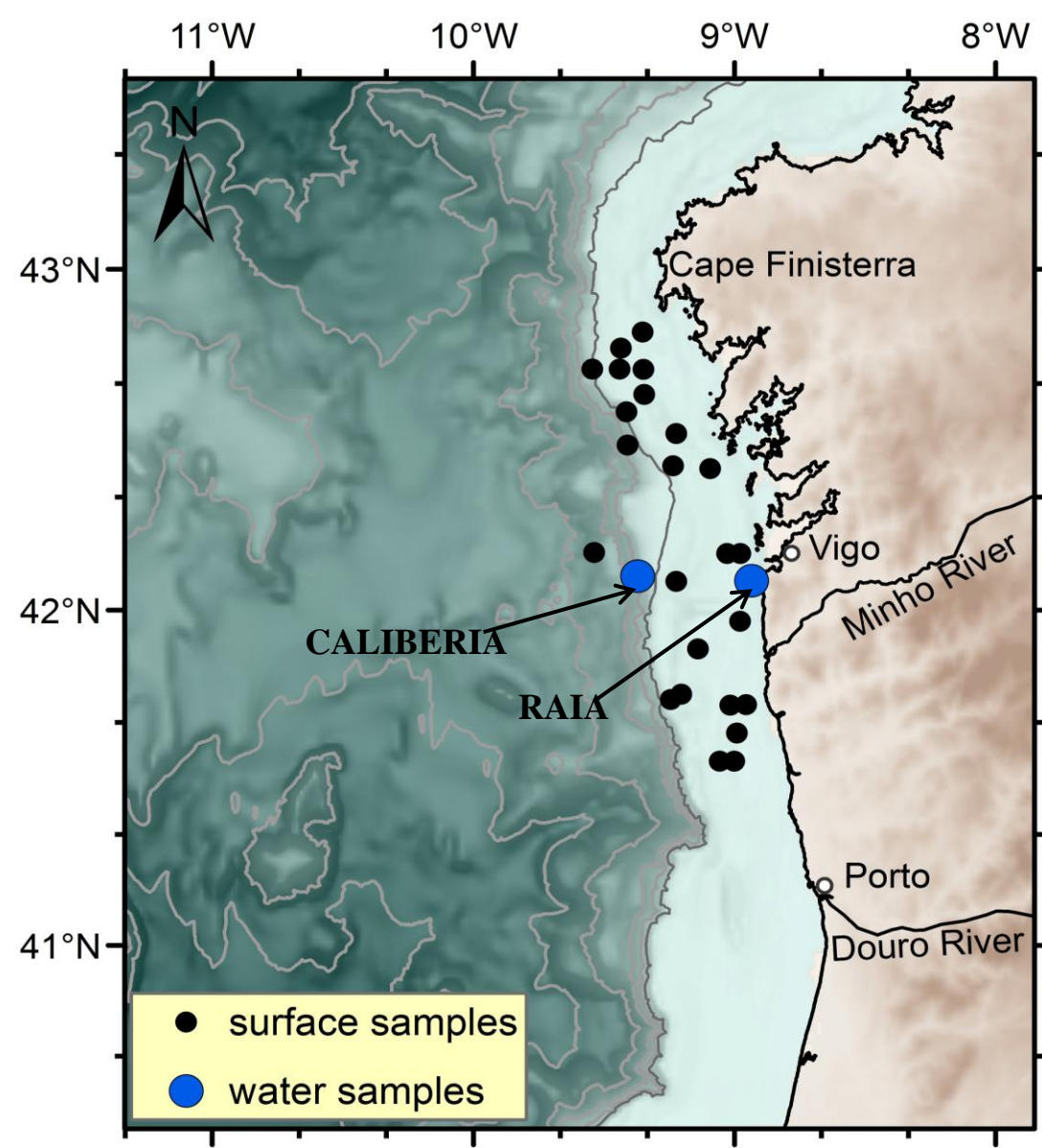


Fig.1. Bathymetric map of the NW Iberian margin showing the positions of the RAIA and CALIBERIA water column sampling sites (blue dots). Locations of surface sediment sampling stations (black dots) are also shown in the figure.

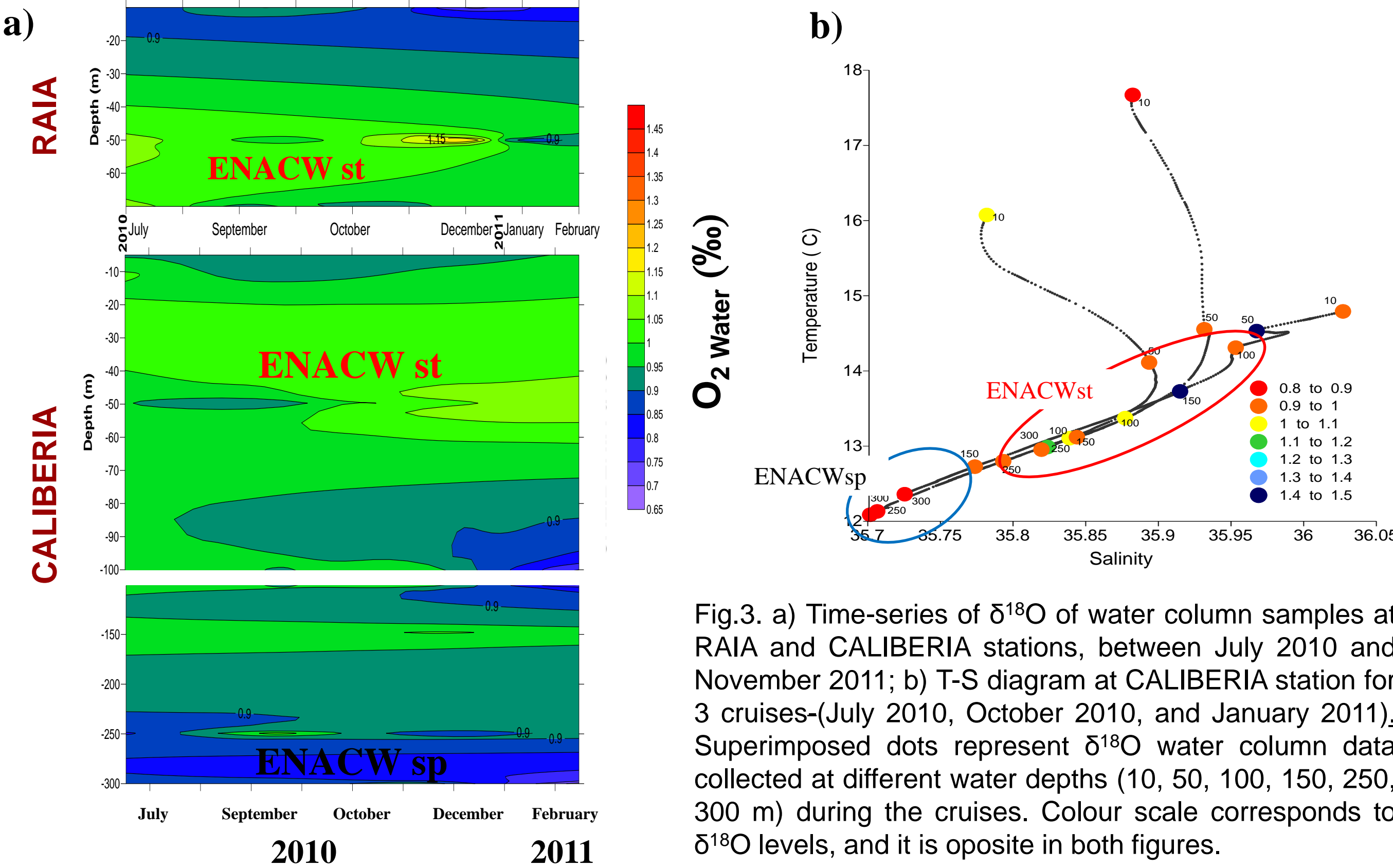


Fig.3. a) Time-series of δ¹⁸O of water column samples at RAIA and CALIBERIA stations, between July 2010 and November 2011; b) T-S diagram at CALIBERIA station for 3 cruises (July 2010, October 2010, and January 2011). Superimposed dots represent δ¹⁸O water column data collected at different water depths (10, 50, 100, 150, 250, 300 m) during the cruises. Colour scale corresponds to δ¹⁸O levels, and it is oposite in both figures.

The surface ocean circulation on the Northwest Iberian margin is characterised by wind-driven spring/summer coastal upwelling that occurs triggered by northerly Portuguese Trade winds that blowing nearly parallel to the coast (Fiúza et al., 1998).

During our study period upwelled waters are well marked by the presence of cold waters with relatively low dissolved oxygen contents and concomitant high nutrient levels (Fig 2b, d). These events can be clearly followed at both stations (RAIA and CALIBERIA sampling sites) from July 2010 to September 2010 and between May 2011 and October 2011. The highest surface temperatures reached at CALIBERIA stations indicate than water column stratification was stronger here than at the inshore RAIA station. High nutrient remineralization over the shelf is shown by the lowest dissolved oxygen levels registered at the end of the summer upwelling period at RAIA station.

The upwelled water is fed by the Eastern North Atlantic Central Water (ENACW) of subtropical origin (ENACWst; Fiúza et al., 1998), during our study years. However, we have also observed ENACW of subpolar origin (ENACWsp), characterised by temperature < 12.6 °C (Fig. 2 and 3). During the rest of the year, coastal convergence conditions prevail especially during the winter period. The most striking feature was the presence of warm (> 15°C) and salty (> 35.9) waters conveyed northward by the Iberian Poleward Current (IPC; Fiúza et al., 1998, Peliz et al., 2005) between November 2010 and February 2011 at both stations, but more evident at CALIBERIA station.

CORE-TOP SEDIMENTS: FAUNAL / GEOCHEMICAL DATA AND HYDROGRAPHIC DOMAINS

Fauna Assemblage

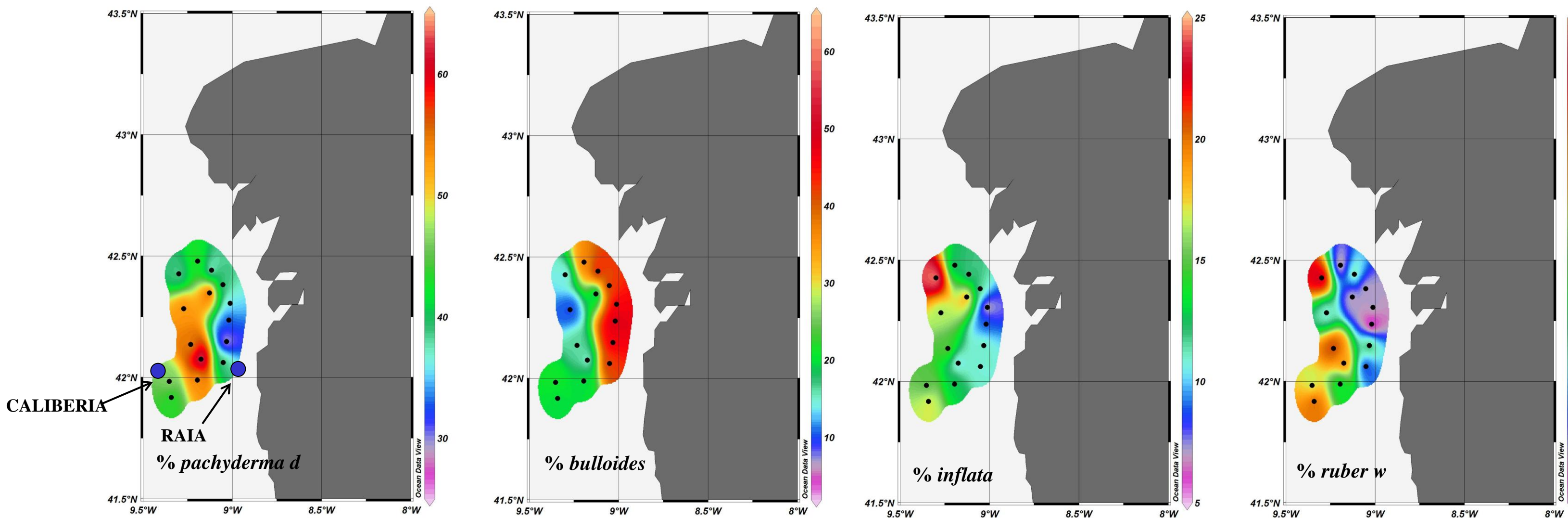


Fig. 4. Distribution of the most abundant planktonic foraminifera species in surface sediment samples along the Northwest Iberian margin: *N. pachyderma* (dextral), *G. bulloides*, *G. inflata*, and *G. ruber* (white).

Calcification Temperature Estimates

All species were calculated using the Mutila et al. (2003) paleotemperature equations to *G. ruber* (white) and *G. bulloides*, *N. pachyderma* (dextral), *G. bulloides* equation was used for *G. inflata*. For the modern δ¹⁸O_{water} we use the average value to Northwest margin (Fig.3), based on the preferred calcification depths of the respective species.

Mg/Ca-derived Temperature

N. pachyderma (d) and *G. inflata* was calculated using the calibration equations of Elderfield and Ganssen (2000). To *G. bulloides* was used the equation of Mashiotta et al. (1999), and for *G. ruber* (w) was applied the calibration equation of Cléroux et al. (2008). The shell geochemistry data is compared to alkenone derived temperatures.

Temperature reconstructions

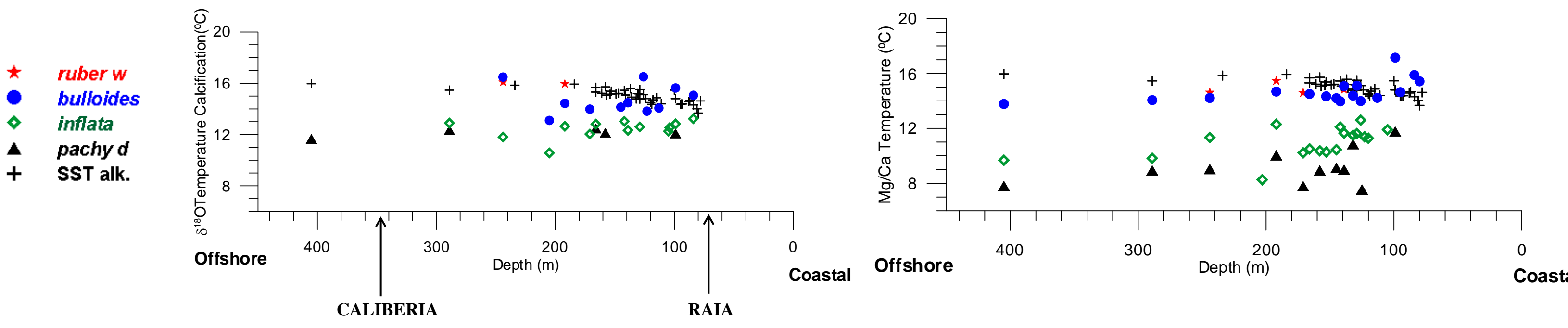


Fig. 5. Core-top δ¹⁸O temperature calcification and Mg/Ca-derived temperature, of *G. bulloides* (blue), *G. ruber* (white) (red), *G. inflata* (green), and *N. pachyderma* (dextral) (black triangles), versus sample water depth along the Northwest margin. Cross symbol also represent the alkenone derived temperature.

CONCLUSIONS

δ¹⁸O and Mg/Ca derived sea surface temperatures (SST) of *G. ruber* (white), *G. inflata*, *G. bulloides*, and *N. pachyderma* (dextral) (Fig. 5) mirror the seasonal temperature changes in the water column (Fig. 2b): *G. bulloides* and *N. pachyderma* (dextral), reflect the spring/summer upwelling. *G. bulloides*, close to the coast, under turbulent conditions and *N. pachyderma* (dextral) under less turbulent conditions. *N. pachyderma* (dextral) is also present in ENACWsp; *G. ruber* (white) reflects the surface conditions of the warm waters of Iberian poleward current in winter season; *G. inflata* indicates the winter mixed layer, is also present in ENACWst.

Mg/Ca and δ¹⁸O *ruber* (white) and *bulloides* derived SST core-top samples (Fig. 5) show a temperature value similar to alkenona derived SST.

The insights gained from this study will be applied to estimate past climate conditions in this particular region and in other upwelling areas.

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